

PCT

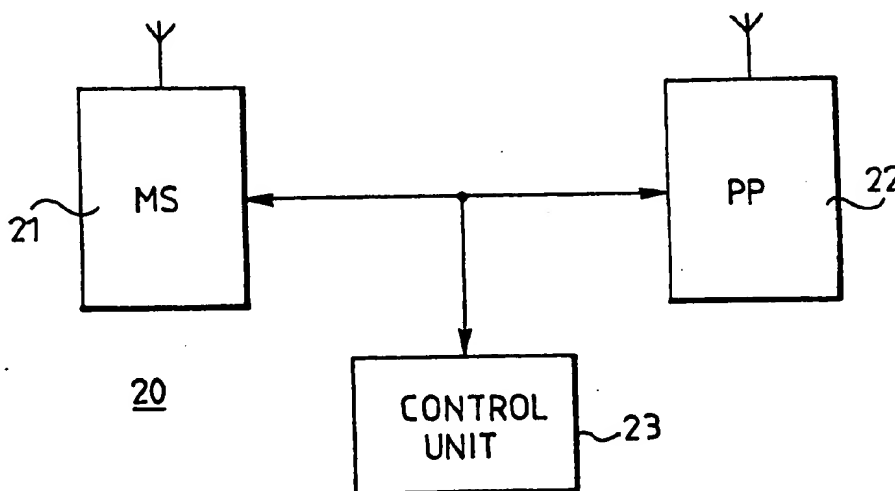
WORLD INTELLECTUAL PROPERTY ORGANIZATION  
International Bureau



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification <sup>6</sup> : <b>H04Q 7/38, H04M 1/72</b>		A1	(11) International Publication Number: <b>WO 95/10922</b> (43) International Publication Date: <b>20 April 1995 (20.04.95)</b>
(21) International Application Number: <b>PCT/FI94/00447</b> (22) International Filing Date: <b>6 October 1994 (06.10.94)</b> (30) Priority Data: <b>9320814.8</b> <b>8 October 1993 (08.10.93)</b> <b>GB</b> (71) Applicants (for all designated States except US): <b>NOKIA TELECOMMUNICATIONS OY [FI/FI]; Mäkkylän puistotie 1, FIN-02600 Espoo (FI). NOKIA MOBILE PHONES LIMITED [FI/FI]; Nakolankatu 8, FIN-24100 Salo (FI).</b> (72) Inventors; and (75) Inventors/Applicants (for US only): <b>BYRNE, John [GB/GB]; 3 Durrell Way, Shepperton, Middlesex TW17 8HR (GB). JÄRVELÄ, Teuvo [FI/FI]; Mäkitorpantie 7 B 16, FIN-00620 Helsinki (FI). MÄENPÄÄ, Sanna [FI/FI]; Otsolahdentie 16 B 64, FIN-02110 Espoo (FI).</b> (74) Agent: <b>OY KOLSTER AB; Iso Roobertinkatu 23, P.O. Box 148, FIN-00121 Helsinki (FI).</b>			(81) Designated States: <b>AU, CN, DE, JP, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).</b>  <b>Published</b> <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>

(54) Title: **DUAL MODE SUBSCRIBER TERMINAL AND A HANDOVER PROCEDURE OF THE DUAL MODE SUBSCRIBER TERMINAL IN A MOBILE TELECOMMUNICATION NETWORK**



(57) Abstract

A dual mode terminal (20) is provided, in which a mobile station (21) of a mobile radio system and a cordless telephone (22) are combined. This kind of terminal may have a connection with both a base station of the mobile radio system and a fixed part of the cordless telephone system. Handover may imply the transfer of a call from a fixed part of the cordless telephone system having a terminal-initiated handover to a base station of the mobile radio system having a network-initiated handover. In order to carry out a proper handover procedure, the cordless telephone part obtains from the mobile station part of the terminal measurement results relating to received signal strengths of the mobile system base stations in the neighborhood. The cordless telephone part of the terminal forwards these measurement results via a fixed part of the cordless telephone system to the mobile exchange of the mobile system in a handover request message. The mobile exchange selects a proper base station for handover and informs the mobile station part of the terminal about the identity of the selected base station via the cordless telephone part.

Best Available Copy

**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	GB	United Kingdom	MR	Mauritania
AU	Australia	GE	Georgia	MW	Malawi
BB	Barbados	GN	Guinea	NE	Niger
BE	Belgium	GR	Greece	NL	Netherlands
BF	Burkina Faso	HU	Hungary	NO	Norway
BG	Bulgaria	IE	Ireland	NZ	New Zealand
BJ	Benin	IT	Italy	PL	Poland
BR	Brazil	JP	Japan	PT	Portugal
BY	Belarus	KE	Kenya	RO	Romania
CA	Canada	KG	Kyrgyzstan	RU	Russian Federation
CF	Central African Republic	KP	Democratic People's Republic of Korea	SD	Sudan
CG	Congo	KR	Republic of Korea	SE	Sweden
CH	Switzerland	KZ	Kazakhstan	SI	Slovenia
CI	Côte d'Ivoire	LI	Liechtenstein	SK	Slovakia
CM	Cameroon	LK	Sri Lanka	SN	Senegal
CN	China	LU	Luxembourg	TD	Chad
CS	Czechoslovakia	LV	Latvia	TG	Togo
CZ	Czech Republic	MC	Monaco	TJ	Tajikistan
DE	Germany	MD	Republic of Moldova	TT	Trinidad and Tobago
DK	Denmark	MG	Madagascar	UA	Ukraine
ES	Spain	ML	Mali	US	United States of America
FI	Finland	MN	Mongolia	UZ	Uzbekistan
FR	France			VN	Viet Nam
GA	Gabon				

Dual mode subscriber terminal and a handover procedure of the dual mode subscriber terminal in a mobile telecommunication network

5           The invention relates to a mobile telecommunications system including a fixed network comprising mobile exchanges, base stations for mobile stations, and cordless telephone base stations connected to and under control of said mobile exchanges. In particular, the present  
10 invention relates to a method for performing handover from the cordless telephone base stations to base stations for mobile stations.

          Conventional cordless telephones operate as an extension to the Public Switched Telephone Network (PSTN). A  
15 cordless telephone system consists of a portable handset and a base station (a fixed part) connected to PSTN. The first cordless telephone systems were analog systems, such as CT1. Recently digital cordless telephone systems, such as CT2 and DECT (Digital European Cordless Telephone) have  
20 been introduced. When a cordless telephone is a subscriber of PSTN, a cordless telephone is accessed by dialing the telephone number associated with the fixed subscriber connection to which the base station is connected. Also the subscriber has access to the PSTN only via the home  
25 base station. In CT2 and DECT, also a telepoint service is introduced, whereby subscriber to the service can make calls away from home via a public base station. Also a common air interface for cordless telephones was introduced to facilitate roaming between systems and so to improve  
30 service coverage for the use.

          There has also been a proposal to combine a cordless telephone system with a cellular mobile telecommunications system to further improve the roaming capabilities by means of utilization of the mobility  
35 control of the cellular network. When combined with the

mobile telecommunications systems, the roaming of the cordless telephone handsets within the cordless telephone systems is fully supported. However, the cordless telephone handset is not able to utilize the more  
5 extensive radio coverage of the supporting cellular network or to perform handover to or from the cellular network. This disadvantage is due to several reasons.

Firstly, the radio interfaces of cordless telephone systems and the mobile radio systems are usually  
10 incompatible.

Secondly, the handover procedures are different. In cordless telephone systems, the handover procedure is usually initiated by the portable terminal. More particularly, when a cordless telephone terminal considers  
15 it necessary to change from one base station to another, the terminal scans the frequency band and selects the appropriate base station for the handover. In most of the mobile telephone systems the handover is controlled by the network. The mobile station only measures the quality of  
20 the radio connection and forwards the measuring results to the fixed network. One of the network elements, for example a mobile exchange, makes a decision for handover on the basis of the obtained information.

It is an object of the invention to provide a subscriber terminal capable of communicating with both a  
25 fixed part of a cordless telephone system and a base station of the mobile radio system.

It is a further object of the invention to provide a method for performing handover from a fixed part of a  
30 cordless telephone system to a base station of a mobile telecommunications system.

One aspect of the invention is, in a mobile telecommunications system including a fixed network comprising mobile exchanges, first base stations connected to said  
35 mobile exchanges, and second base stations of a cordless

telephone system, said second base stations being connected to and under control of said mobile exchanges, dual mode subscriber terminals having a mobile station part for radio communication with said first base stations and a

5 cordless telephone part for radio communication with said second base stations; a method for performing handover from one of said second base stations to one of said first base stations, comprising the steps of

10 measuring field strengths of said first base stations at said mobile station part of said dual mode terminal and storing measurement results,

detecting low quality of connection between one of said second base stations and said cordless telephone part of said dual mode terminal during an on-going call,

15 obtaining the stored measurement results from said mobile station part to said cordless telephone part of said dual mode terminal,

sending a message including said obtained measurement results and terminal identity to said one of said

20 second base stations by said cordless telephone part of said dual mode terminal,

sending a handover request message from said one of said second base stations to one of said mobile exchanges in response to receipt of said message including said

25 measurement results, said handover request message including said terminal identity and said measurement results,

selecting one of said first base stations on the basis of said measurement results,

30 sending a handover command message to said one of said second base stations from said one of said mobile exchanges, said message including the information of said selected one of said first base stations,

sending a message to said cordless telephone part

35 of said dual mode terminal from said one of said second

base stations, said message including information of said selected one of said first base stations,

5 forwarding said information of said selected one of said first base stations to said mobile station part from said cordless telephone part of said dual mode terminal,

establishing a connection between said mobile station part of said dual mode terminal and said selected one of said first base stations,

10 releasing said connection between said cordless telephone part of said dual mode terminal and said one of said second base stations.

Another aspect of the invention is a mobile telecommunications system including a fixed network comprising mobile exchanges, first base stations connected to said mobile exchanges and second base stations of a cordless telephone system, said second base stations being connected to and under control of said mobile exchanges; a dual mode subscriber terminal comprising

20 a mobile station part for radio communication with said first base stations,

a cordless telephone part for radio communication with said second base stations,

25 means for measuring field strengths of said first base stations at said mobile station part of said dual mode terminal and storing measurement results,

means for monitoring quality of connection between one of said second base stations and said cordless telephone part of said dual mode terminal during an ongoing call,

30 means for requesting said stored measurement results from said mobile station part to said cordless telephone part of said dual mode terminal in response to detecting low quality of said connection,

35 means for sending a message including said obtained measurement results and a terminal identity to said one of

said second base stations from said cordless telephone part of said dual mode terminal,

means for receiving a message at said cordless telephone part of said dual mode terminal from said one of said second base stations, said message including information on the one of said first base stations which is selected for handover,

means for forwarding said information of said selected one of said first base stations to said mobile station part from said cordless telephone part of said dual mode terminal so as to establish a connection between said mobile station part of said dual mode terminal and said selected one of said first base stations.

In the invention, a dual mode terminal is utilized, in which a mobile station of a mobile radio system and a cordless telephone are combined. This kind of terminal can have a connection with both a base station of the mobile radio system and a fixed part of the cordless telephone system. Handover in the case of this dual mode terminal can imply the transfer of a call from a fixed part of the cordless telephone system to a base station of the mobile radio system. As noted before, the primary problem in this concept is that two systems utilizing different handover principles are combined. In the cordless telephone systems, such as DECT, handover is a terminal controlled procedure and the terminal will make a decision when the handover is needed. In the mobile radio system, such as GSM, the network will always decide when to perform a handover.

In the present invention the cordless telephone part of the dual mode terminal will initiate the handover procedure from a cordless telephone system to a mobile radio system, when the cordless telephone part of the dual mode terminal recognizes that the quality of connection is getting worse and the mobile radio system could offer a

better connection. In order to carry out a proper handover procedure, the cordless telephone part obtains from the mobile station part of the terminal measurement results relating to received signal strength of the mobile system base stations in the neighborhood. The cordless telephone part of the terminal forward these measurement results via a fixed part of the cordless telephone system to the mobile exchange of the mobile system in a handover request message. The mobile exchange selects a proper base station for a handover and informs the cordless telephone part of the terminal about the identity of the selected base station via the fixed part of the cordless telephone system. The cordless telephone part of the terminal forwards the identity of the base station to the mobile station part of the terminal which initiates an establishment of a connection with the selected base station. After the establishment of the connection is completed the mobile station part informs the cordless telephone part about the matter and the latter releases the radio path of the cordless telephone system. Thus, the invention allows a terminal initiated handover from a cordless telephone system to a mobile system which utilizes a network initiated handover procedure.

The description of the preferred embodiments of the invention will now be made with reference to the attached drawings, in which

Figure 1 shows a general diagram of a mobile radio system which supports a cordless telephone systems,

Figure 2 shows a general diagram of a dual mode subscriber terminal according the invention, and

Figure 3 is a signalling diagram for the handover method according to the invention.

In the following the invention will be described using digital cellular radio system known as GSM (Groupes Speciale Mobile) as an example of the mobile radio system



and DECT (Digital European Cordless Telephone) as an example of cordless telephone systems. However, the invention is not intended to be restricted to these systems. The invention may be applied to any mobile radio system.

5           Figure 1 shows the functional environment of GSM/DECT dual mode terminal. In figure 1, both base stations BSS of GSM system and fixed parts FP of DECT system are connected to the GSM mobile exchange MSC. One of the DECT fixed parts FP is shown to be connected to the  
10       private branch exchange PBX which is further connected to the MSC. The MSC may be connected to other MSC:s, PSTN (Public Switched Telephone Network) or ISDN (Integrated Services Data Network). The MSC is also connected to the visitor location register VLR, which is a data base main-  
15       taining subscriber files on the subscribers visiting in the area of the MSC, and to a home location register HLR which is a data base maintaining subscriber files on all the subscribers in the system, and further to an authentication center AC and to an equipment identity  
20       register EIR. For more detailed description of the operation and structure of GSM system, a reference is made to GSM specifications and to a book "The GSM system for mobile communication", M. Mouly and M. Pautet, Palaiseau, France, ISBN:2 9507190-0-7.

25           Figure 2 shows a general view of a GSM/DECT dual mode subscriber terminal according to the invention. The terminal 20 consists of a GSM mobile station part MS 21 and a DECT portable terminal part PP 22. The GSM part of the dual mode terminal MS is used when communicating with  
30       GSM base stations. The DECT part PP of the dual mode terminal is used when communicating with DECT fixed parts FP. Both MS and PP include all the necessary equipment, such as radio transceivers, for signalling and communicating over the respective radio interface. It is  
35       normally advantageous to embody at least some functions

and circuits, such as display, keyboard, power supply, etc., by means of a common circuitry. In Fig. 2, a common control unit 23 is connected to MS and PP parts of the dual mode terminal for controlling the operation thereof.

5           The GSM network provides a full mobility management support for the cordless telephone systems connected to it. Thus, the GSM network maintains files on the cordless telephone subscribers and the current location thereof and is therefore able to route the calls addressed to the cordless telephone to their current locations. Basically, the  
10           cordless telephone subscribers are handled in a similar manner with the ordinary GSM subscribers.

          Thus, the dual mode terminal according to the invention is capable of communicating with both GSM base stations and DECT base stations (fixed parts) FP. Consequently, a dual mode terminal should also be able to roam anywhere in the system. However, problems are encountered when the handover from DECT fixed part (or vice versa) is required, since in the DECT system handover is a  
15           terminal controlled procedure and the terminal will make a decision when the handover is needed. In the GSM system network will always decide when to perform a handover.

          An example of the handover procedure according to the invention from DECT fixed part to the GSM base station  
25           will be described in the following with reference to figure 3. Firstly, it is assumed that the cordless telephone part PP of the dual mode terminal has a DECT connection and an on-going call via fixed part FP of the DECT system. The mobile station part MS of the dual mode terminal is  
30           simultaneously measuring the signal strength of the neighboring GSM base stations and stores the measurement results.

          In step 1 of Figure 3, when detecting during the call that the quality of connection is getting worse, the  
35           PP will start a handover procedure from the DECT system to

the GSM system. Firstly, the PP will request the stored measurement results from the MS part of the terminal. After obtaining the measurement results the handover procedure is initiated by sending a MM INFO REQuest message according to the DECT common interface specification (DECT CI) from the PP part of the terminal to the DECT fixed part FP. This message will carry the obtained measurement results in IWU-TO-IWU parameter. The message includes also a portable identity.

10 In step 2 of the figure 3, when the DECT fixed part FP receives the MM-INFO-REQ message from PP part of the dual mode terminal, it will send a DM H/O REQuired message according to DSS.1+ protocol to the mobile exchange MSC. The DSS.1+ protocol is the DSS.1 protocol enhanced with mobility management. This message includes the following information elements: Portable identity, a Cause field including information of the dual mode handover, and IWU-TO-IWU parameter including the measurement results.

20 In step 3 of figure 3, the MSC receives the measurement results in the DM H/Q REQ message from DECT fixed part FP. MSC decides on the basis of the measurement results to which GSM base station BSS it should perform the handover. The MSC sends a H/O REQ message according to specification GSM 08.08 to a base station BSS it has selected for handover, to indicate that the dual mode terminal is to be handed over to that GSM base station BSS.

25 In step 4 of the figure 3, H/O ACK message according to the specification GSM 08.08 is sent from the selected GSM base station BSS to the MSC. This message indicates that the request to support a handover at the selected BSS can be supported by this BSS. The message further indicates to which radio channel the dual mode terminal should be directed.

30 In step 5 of figure 3, the MSC sends a DM H/O CMD message according to DSS.1+ protocol to the DECT fixed

35

part FP to indicate that a handover procedure is available. Also the information of the selected GSM base station BSS is included. Thus the message includes the following information elements: a portable identity and a BSS identity.

In step 6 the DECT fixed part FP sends to the cordless telephone part PP of the dual mode terminal a MM INFO ACCEPT message according to DECT CI. This message includes information of the selected GSM base station BSS where handover should be done. Thus, this message includes the following information elements: IWU-TO-IWU parameter, including a BSS identity and a H/O reference.

In step 7 the cordless telephone part PP delivers the identity of the selected GSM base station BSS to the mobile station part MS of the dual mode terminal and the mobile station part MS sends a H/O ACCESS message according to the specification GSM 04.08 to the selected GSM base station BSS.

In step 8, when the selected GSM base station BSS receives the H/O ACCESS message from the mobile station part MS it will respond with a PHYS INFO message according to the specification GSM 04.08 to the mobile station part MS in order to stop sending of access bursts from the MS and to activate the physical channels for the connection.

In step 9 the mobile station part of the dual mode terminal sends a H/O COMPLETE message according to the specification GSM 08.08 to the MSC to indicate that the mobile station part MS of the dual mode terminal has successfully accessed the selected GSM base station BSS. The mobile station part MS of the dual mode terminal will inform the cordless telephone part PP of the terminal that the handover is completed and the cordless telephone part of the terminal can release the former DECT connection.

## Claims

1. In a mobile telecommunications system including a fixed network comprising mobile exchanges, first base stations connected to said mobile exchanges and second base stations of a cordless telephone system, said second base stations being connected to and under control of said mobile exchanges, dual mode subscriber terminals having a mobile station part for radio communication with said first base stations and a cordless telephone part for radio communication with said second base stations; a method for performing handover from one of said second base stations to one of said first base stations, comprising the steps of
- 15       measuring the field strengths of said first base stations at said mobile station part of said dual mode terminal and storing measurement results,
- detecting low quality of connection between one of said second base stations and said cordless telephone part
- 20       of said dual mode terminal during an on-going call,
- obtaining the stored measurement results from said mobile station part by said cordless telephone part of said dual mode terminal,
- sending a message including said obtained measurement results and a terminal identity to said one of said second base stations from said cordless telephone part of said dual mode terminal,
- 25       sending a handover request message from said one of said second base stations to one of said mobile exchanges in response to receipt of said message including said measurement results, said handover request message including said terminal identity and said measurement results,
- 30       selecting one of said first base stations on the basis of said measurement results,
- 35

sending a handover command message to said one of said second base stations from said one of said mobile exchanges, said message including the information of said selected one of said first base stations,

5            sending a message to said cordless telephone part of said dual mode terminal from said one of said second base stations, said message including information of said selected one of said first base stations,

10           forwarding said information of said selected one of said first base stations to said mobile station part via said cordless telephone part of said dual mode terminal,

             establishing a connection between said mobile station part of said dual mode terminal and said selected one of said first base stations,

15           releasing said connection between said cordless telephone part of said dual mode terminal and said one of said second base stations.

             2. A method according to claim 1, comprising further steps of

20           sending a handover request message to said selected one of said first base stations from said one of said mobile exchanges to indicate that said dual mode terminal is to be handed over to said selected base station,

             sending a handover acknowledgement message from  
25           said selected one of said first base stations to said one of the mobile exchanges, said message indicating the radio channel to which the dual mode terminal should be directed.

30           3. A method according to claim 1 or 2, wherein said step of establishing a connection comprises the steps of

             sending a handover access message from said mobile station part of said dual mode terminal to said selected one of said first base stations,

35           sending an acknowledgement message to said mobile station part from said selected one of said first base

stations,

    sending a handover completed message to said selected one of said first base stations from said mobile station part,

5       sending a handover completed message from said selected one of said first base stations to said one of said mobile exchanges.

4. In a mobile telecommunications system including a fixed network comprising mobile exchanges, first base  
10       stations connected to said mobile exchanges, and second base stations of a cordless telephone system, said second base stations being connected to and under control of said mobile exchanges; a dual mode subscriber terminal comprising

15       a mobile station part for radio communication with said first base stations,

    a cordless telephone part for radio communication with said second base stations,

20       means for measuring the field strengths of said first base stations at said mobile station part of said dual mode terminal and storing measurement results,

    means for monitoring quality of connection between one of the second base stations and said cordless telephone part of said dual mode terminal during an on-  
25       going call,

    means for requesting said stored measurement results from said mobile station part to said cordless telephone part of said dual mode terminal in response to detecting low quality of said connection,

30       means for sending a message including said obtained measurement results and a terminal identity to said one of said second base stations from said cordless telephone part of said dual mode terminal,

35       means for receiving a message at said cordless telephone part of said dual mode terminal from said one of

said second base stations, said message including information on the one of said first base stations which is selected for handover,

- 5        means for forwarding said information of said selected one of said first base stations to said mobile station part from said cordless telephone part of said dual mode terminal so as to establish a connection between said mobile station part of said dual mode terminal and said selected one of said first base stations.



1/2

RADIO  
INTERFACE

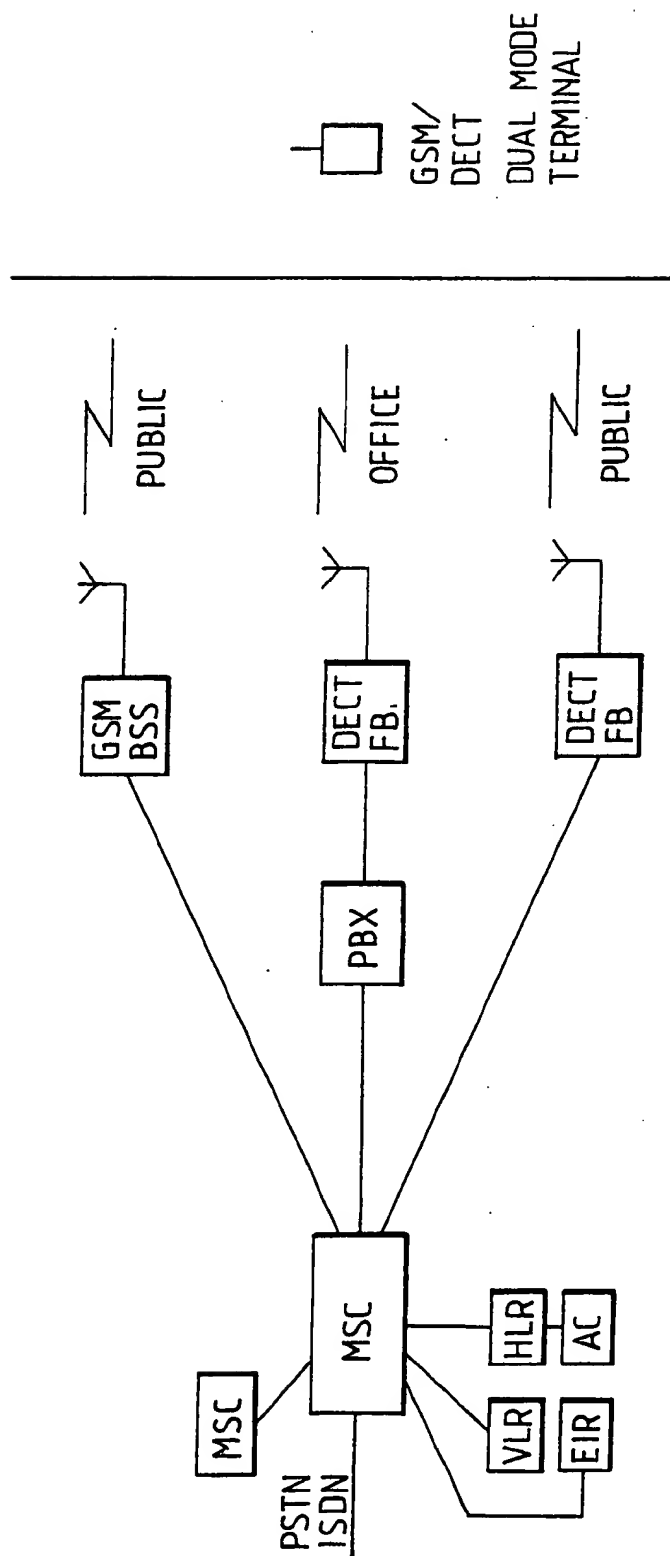


FIG. 1

2/2

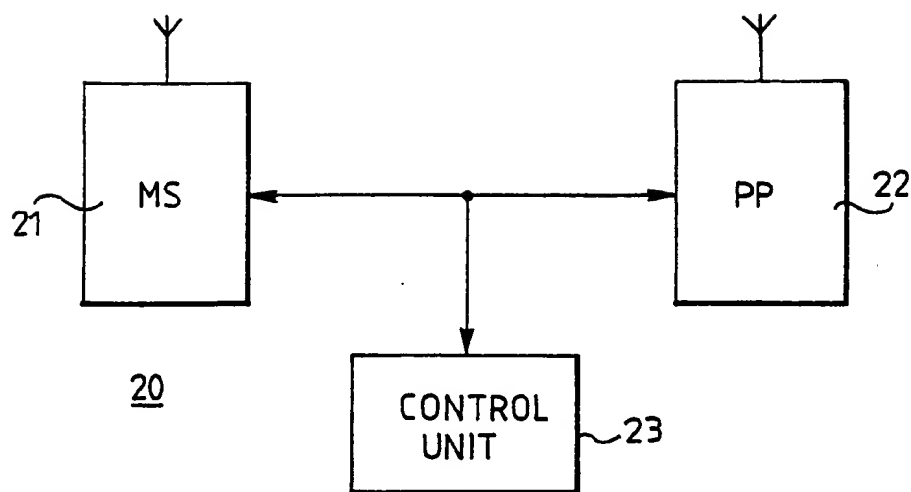


FIG. 2

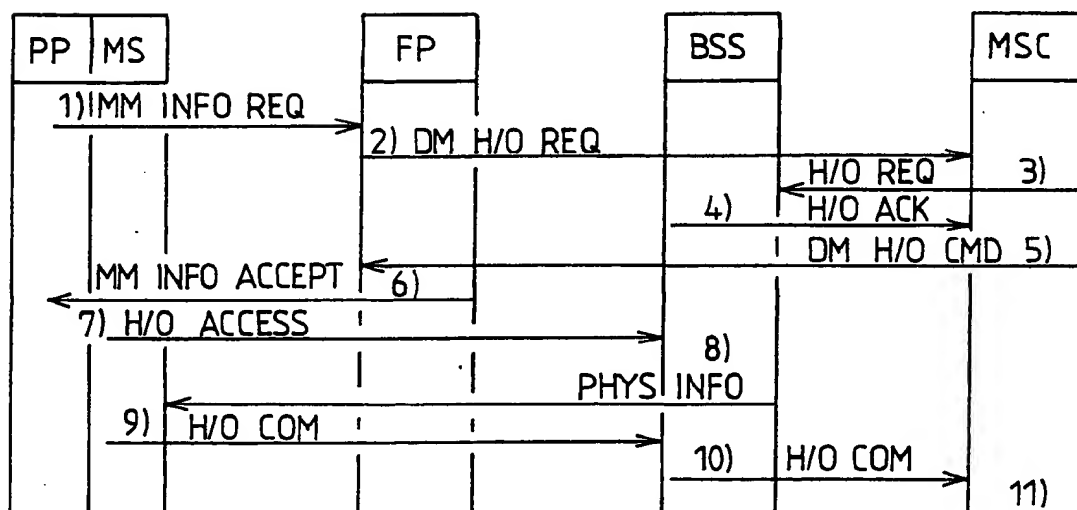


FIG. 3

## A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04Q 7/38, H04M 1/72

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H04Q, H04M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO, A1, 9316549 (MOTOROLA, INC.), 19 August 1993 (19.08.93), page 13, line 1 - page 16, line 6, figures 6B,7A,7B, abstract  --	1-4
A	GB, A, 2225512 (MOTOROLA INC), 30 May 1990 (30.05.90), page 7, line 1 - page 8, line 21; page 14, line 9 - page 15, line 22, figures 2,8, abstract  -- -----	1-4

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

## \* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"B" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&amp;" document member of the same patent family

Date of the actual completion of the international search

17 February 1995

Date of mailing of the international search report

20 -02- 1995

Name and mailing address of the ISA/

Swedish Patent Office

Box 5055, S-102 42 STOCKHOLM

Facsimile No. +46 8 666 02 86

Authorized officer

Bengt Jonsson

Telephone No. +46 8 782 25 00

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

31/12/94

International application No.  
**PCT/FI 94/00447**

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO-A1- 9316549	19/08/93	BR-A- 9304158	02/08/94
		CN-A- 1076817	29/09/93
		FR-A- 2687875	27/08/93
		GB-A- 2271040	30/03/94
		JP-T- 6507059	04/08/94
<hr/>			
GB-A- 2225512	30/05/90	JP-A- 3001621	08/01/91
		US-A- 4989230	29/01/91
		US-A- 5127042	30/06/92
		US-A- 5367558	22/11/94
<hr/>			

**This Page is Inserted by IFW Indexing and Scanning  
Operations and is not part of the Official Record**

**BEST AVAILABLE IMAGES**

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ **BLACK BORDERS**
- ☐ **IMAGE CUT OFF AT TOP, BOTTOM OR SIDES**
- ☐ **FADED TEXT OR DRAWING**
- ☐ **BLURRED OR ILLEGIBLE TEXT OR DRAWING**
- ☐ **SKEWED/SLANTED IMAGES**
- ☐ **COLOR OR BLACK AND WHITE PHOTOGRAPHS**
- ☐ **GRAY SCALE DOCUMENTS**
- ☐ **LINES OR MARKS ON ORIGINAL DOCUMENT**
- ☐ **REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY**
- ☐ **OTHER:** \_\_\_\_\_

**IMAGES ARE BEST AVAILABLE COPY.**

**As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.**

This Page Blank (uspto)